THE PROGRESSIVE FISH CULTURIST

NEWS AND VIEWS FROM MANY SOURCES ON PRACTICAL HATCHERY PROBLEMS

ISSUED BY THE

U. S. DEPARTMENT OF COMMERCE

DANIEL C. ROPER, SECRETARY

BUREAU OF FISHERIES

FRANK T. BELL, COMMISSIONER

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WASHINGTON

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THE PROGRESSIVE FISH CULTURIST

A SERIAL memorandum published occasionally for the advancement of Federal, State, and private fish culture and fishery management in fresh waters.

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BUREAU OF FISHERIES, U. S. DEPARTMENT OF COMMERCE

Memorandum I-131 Washington, D. C., May 1938 No. 38

PRACTICAL pH DETERMINATIONS

By M. M. Ellis

U. S. Bureau of Fisheries, Columbia, Missouri

THE MEASUREMENT of the relative acidity, that is, the hydrogen-ion concentration or the pH value of water and various other fluids has become so important in several fields of science that pH determinations are almost routine in many industrial processes and have large significance in various phases of limnology and aquatic biology. Potentiometers, glass electrodes, calomel cells, and numerous types of colorimetric methods have placed powerful and exact tools in the hands of laboratory investigators, but cost, intricacy of operation and often the sheer bulk of the needed equipment have limited greatly the application of these methods to the practical problems of the fish culturist and the field biologist. Paper strips have supplied perhaps the simplest means of making quick measurements of the relative acidity or alkalinity of waters and solutions, but the common test papers, namely congo red, litmus, and turmeric can be used only to determine whether a given water is more or less acidic than the pH value at the turning point of the particular dye, and are restricted therefore to specific applications.

Recently a new dye has been synthetized, technically known under the formidable name of sodium dinitrophenyl-azo-napthol sulphonate which like many other indicator dyes has several pronounced color phases but which has the added advantage of being useable in the test paper form. Paper which has been saturated with this dye, dried and then cut into strips approximately 2 x ¼ inches, is now obtainable in convenient glass vials containing 100 such strips, from chemical supply houses at a very nominal cost under the trade name of "nitrazine" test paper.

The determination of pH values with nitrazine paper is very simple. A single strip of the paper is held between the thumb and forefinger and the free end of the strip either immersed quickly into the water to be tested or moistened with the water

by means of a clean medicine dropper or glass rod. If the paper is dipped into the water it must not be held there longer than required to wet the paper as the dye readily dissolves out. Whether the paper be immersed or moistened directly one minute later the color of the wet portion of the strip is compared with a small color chart of seven squares (supplied by the manufacturers with the paper). These seven colors, ranging from bright yellow through olive green to deep indigo blue are sharply different and correspond to the pH values of 4.5, 5.0, 5.5, 6.0, 6.5, 7.0, and 7.5 respectively. If the paper turns a very dark blue, and shows a deeper color than the last square on the chart the pH value is greater than pH 7.8, which is approximately the upper limit of this dye. In making determinations with nitrazine or any other test paper the wet part of the slip should not be allowed to touch anything lest soluble foreign matter be picked up and the reading changed. Besides, the observer should not be smoking as tobacco smoke and fumes of almost any sort may alter the reading of the wet sensitive paper.

The interpretation of these readings is not difficult. Careful observations by physical chemists have established pH 7.0 as the neutral point, that is, at pH 7.0 the acidic and alkaline constituents are in exact balance, and the water or solution neither acidic nor alkaline. Values less than 7.0, namely pH readings in which the numerical value is smaller than 7.0 are in the acid range, the smaller the number the greater the acidity. Conversely any pH reading greater than 7.0 is in the alkaline range, the larger the number the greater the alkalinity.

Having obtained a simple and inexpensive method for the determination of pH values there are many ways in which measurements of relative acidity may be turned to practical account in fish cultural and field operations. Some specific applications will be pointed out.

During the past seven years members of the staff of the Columbia (Missouri) Field Unit of the U. S. Bureau of Fisheries have made more than 15,000 determinations of the relative acidity of the fresh waters of the United States. Over 97 percent of the pH values of waters in which desirable fish were thriving lie between pH 6.7 and pH 8.5, that is, waters supporting good faunae of fresh-water fishes, are for the most part slightly alkaline. Additional observations (Ellis, M. M., Bull. 22, U. S. Bureau of Fisheries, 1937) have shown that natural trout waters, mountain streams and mountain lakes usually have even a narrower pH range lying between 6.5 and 7.6, most of the values being slightly above pH 7.0. The difference in trout waters and mountain streams as compared with the general average of inland waters is due to the fact that mountain waters rarely carry much dissolved mineral matter. Bog waters and swamp waters are consistently acidic in reaction, occasionally having an acidity as great as pH 4.5.

If pH determinations be made on unpolluted streams or hatchery water supplies, it will be found that although the pH values for any given stream or other water supply will fluctuate more or less over a period of months and somewhat with the temperature and season of the year these variations will not be large. However, many stream pollutants, decomposing matter in the water, and the reduction of dis-

solved oxygen tend to make water more acid. Therefore should the pH value of the stream or water supply shift toward or into the acid range, that is, should the actual numerical value of the pH readings become less than the average values previously found it is definite proof that conditions have changed, and some one of the above factors or a combination of them very likely will be found to be the cause.

Field determinations of the pH of waters either at the source of the supply or at the place where detrimental conditions are suspected are often very important if changes in water conditions are to be properly evaluated. Although many pH measurements may show only normal and acceptable values unusual readings frequently give warnings or indications of changes in the water supply before conditions actually lethal to fish develop. On occasion conditions change abruptly, a catastrophe results, and a few hours later although the fish have been killed the water may have returned to approximately its normal state. It may be very difficult for investigators arriving several days later to be sure just what the conditions were at the time of the trouble.

Again although detrimental changes in the water may develop slowly it may not be possible to send special equipment and observers to the particular stream or hatchery at the time. Water samples can be collected and certain of their characteristics determined after shipment to a properly equipped laboratory but the pH value which may be critical in the interpretation of these other findings can only be made immediately after the sample is taken since dissolves gases and other volatile substances often leave the water if it is allowed to stand even a few minutes.

The writer has secured the cooperation of several hatchery men and others in pH determinations and has demonstrated the feasibility of the practical methods suggested in this discussion. Recently it became necessary to know the pH of waters which were killing fish at a certain government hatchery. A small color paper carrying the seven squares previously described was glued to a 3 x 5 inch card and covered with cellophane. This card and a few of the test strips were sent by air mail to the hatchery and 48 hours later the superintendent returned the card together with the pH readings. Important information was obtained in this way and the assays were not interrupted although the hatchery was over 1,200 miles away from the laboratory.

Many times the pH readings of water in rearing and holding ponds can supply important information to the fish culturist. As impounded waters, particularly small units such as hatchery ponds, are often much more affected by luxurious growth of vegetation, decomposition of material on the bottom, reduction in dissolved oxygen, and rapid changes in temperature, than are flowing streams and the larger natural bodies of water, it is not surprising to find that the relative acidity or alkalinity of ponds and small impoundments may change very abruptly to the detriment of the fish in these waters. Wunder (Bull. Francaise de Pisciculture, Mars, 1930) points out that in European pond culture waters more acid than pH 4.0 are strongly toxic to fish; that waters having a pH between 4.0 and 6.0 are so acidic as to be toxic, detrimental or harmful to fish; and, that alkaline waters ranging from neutral, pH 7.0, to pH 9.0 are excellent for pond cultural operations. This general range of

pH values for ponds and other impounded waters has been confirmed in the United States by various persons and by field observations of the writer.

Although the transplanting of fish has been carried on for years largely on the basis of the experience of fish culturists, and although it has been shown that bass, sunfish, and other pond fishes can survive rather abrupt changes in the relative acidity of the water if these changes be on the lakaline side of the neutral point (Wiebe, A. H., Trans. Amer. Micros. Soc., Vol. 50, p. 380, 1931), at least some of the unsuccessful plantings could have been avoided had the relative acidity of the stream to receive the fish been compared previous to the planting with the pH value of the water in which the fish were living at the time. The importance of such precautions is increasing in regions where streams receive intermittent industrial pollution.

Concerning the general interpretations of water conditions as indicated by the pH readings the following statements may be made. Waters having pH value of 4.5 or below are almost certain to be lethal to fish life and barring a few exceptions are to be regarded as presenting acute conditions demanding immediate attention; waters between pH 5.0 and pH 6.0 are usually unfavorable, often seriously detrimental to fish life, and should be looked upon as warranting an investigation of the causes producing this acid condition; readings between pH 6.5 and 9.0 indicate that other things being equal the water is favorable for most forms of fish life, fish food and the common inhabitants of fresh waters, with the optimum lying between pH 7.2 and pH 8.6. Above pH 9.2, that is, for waters more alkaline than pH 9.2, the cause of the high alkalinity should be determined as any increase in alkalinity beyond this pH level rapidly may become hazardous or lethal for fish life. As a practical procedure any shift in pH toward or into the acid range even though the new value be within the favorable zone, should be investigated as pointing to some factor of change which if left uncontrolled may produce detrimental conditions.

Since nitrazine paper covers only part of the alkaline range tolerated by fish life a second test paper is helpful in determining the upper limit of the alkaline range. Turmeric paper test slips are also obtainable from chemical supply houses at nominal cost. These slips are yellow in color but turn a deep bright brown at pH 9.2 Turmeric paper therefore has only one color change valuable for field work. However with nitrazine paper to cover the acid range and turmeric paper to mark the end of the desirable alkaline range one is prepared for both emergencies. Turmeric paper is handled much the same as nitrazine paper, that is one end of the turmeric strip is dipped into the water to be tested, and if this wet end turns a definite deep brown in one minute the pH of the water is 9.2 or greater. No color chart is required with turmeric paper since but a single change of color is noted.

In conclusion it is not argued that relative acidity measurements are indispensable nor that they will answer all of the questions even if made, as several other factors may be involved in determining whether water conditions be suitable or not for fish life. However, if utilizing the simple and practical methods now available, pH measurements are taken from time to time and especially when critical or unusual water conditions arise, information will be obtained which will help solve at least some of the difficulties.

COBEQUID HATCHERY - FISH PRODUCTION IN SECOND RIVER, AND A NEW METHOD OF DISEASE CONTROL

By R. H. M'Gonigle and M. W. Smith
Fishery Research Board of Canada

IN 1936, THE Department of Fisheries of Canada was planning to open a new hatchery, situated in the Cobequid Hills of Nova Scotia, in Cumberland County, on one of the tributaries of River Philip, which is one of the best salmon streams of the Canadian Maritimes.

The difficulties and discouragements which had attended the operation of older, established hatcheries, in the way of parasitic infections and other disease, induced the Fish Cultural Branch, under the direction of J. A. Rodd, to endeavor to give the new hatchery a good start, by trying at least to remove the source of natural infection.

Everyone interested in fish culture is doubtless familiar with the words of advice given by Dr. H. S. Davis, in CARE AND DISEASES OF TROUT, namely: "Under no circumstances should fish of any kind be allowed in the spring from which a hatchery obtains its supply of water."

The present case was somewhat more complicated in that the source of water was a stream about 25 miles long (including all its branches) as shown in the accompanying plan. The stream was almost entirely spring fed, although in its upper portions there was a certain contamination by warm, brown, bog water.

That it is exceedingly difficult to eradicate all the fish in any body of water by netting or traps is recognized, and since the Director of Fish Culture was aware of the results secured by certain methods of fish poisoning (the use of copper sulphate for lake treatments and quick-lime for certain small streams) the question of destroying all the fish in the feeder stream of the Cobequid hatchery by poisoning was raised by him, and was referred to the Biological Board of Canada (as it was then known) for consideration and report.

The work of Dr. R. W. Eschmeyer in Michigan had come to the attention of certain members of the staff of the Fisheries Research Board of Canada (as it is now called) and certain laboratory-type tests were carried out with this poison which had been used successfully by the Michigan investigators. This poison is called Derris Root and in this instance was of 5 percent rotenone content. The material commended itself to the writers because it was very much more toxic to fish than lime or copper sulphate. Furthermore, it was lighter; whereas tons of lime would have been needed,

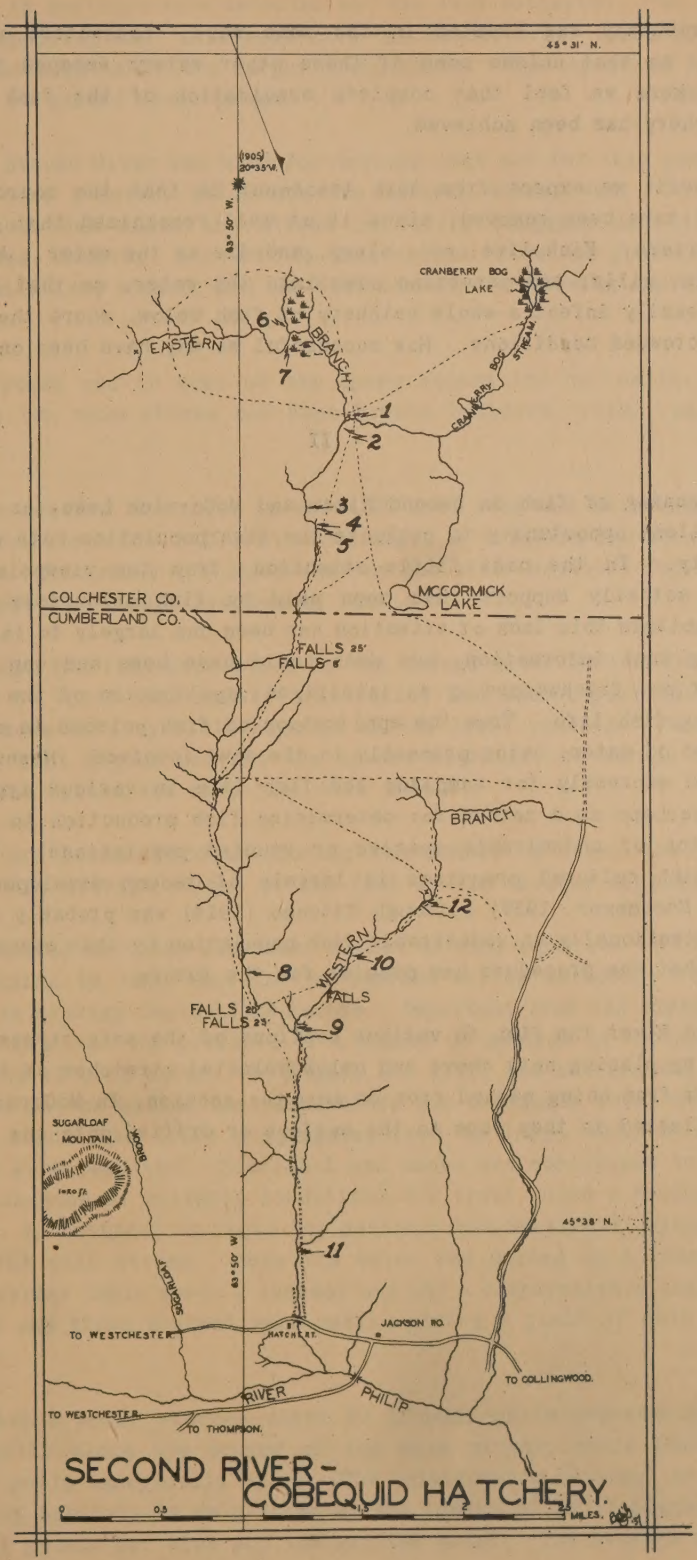
only about 200 pounds of this poison would be required for the whole system. There was a small six-acre lake (McCormick) also to be treated, at the head waters, and it was believed that lime would be unsatisfactory although copper sulphate could be employed quite well. In the final analysis lime was discarded because the cost of the material would have been almost as much and the character of the country, back in the hills, would have necessitated the use of pack horses, whereas the Derris Root powder could be carried in pack sacks. The difficulties of the country may be judged fairly well from the trails shown in the accompanying map, if it be remembered that the country was heavily wooded with dense second growth and the streams were very heavily fringed with alders.

It was decided to try this poison in August, when the run-off would be least and when the temperatures would be greatest, to secure the maximum result with the least outlay of funds.

At that time of year there was no water running out of McCormick Lake, so as a field experiment it was treated first. About 80 pounds of powder were used. It required about an hour to complete the application, which was accomplished by placing the powder in open-meshed burlap sacks and towing the sacks behind a rowboat. This is the same manner in which copper sulphate is applied, except that the sacks had to be squeezed constantly during the towing to force out the powder. It proved to be a very effective method of application for we believe every fish in the lake was destroyed. Before we had finished the application of the poison fish were dying and coming to the surface. Most of the dead fish were picked up on the surface, that afternoon, although we continued to pick up a few for the next three days. The waters continued to be toxic to fish placed in the lake in a wire cage for about a month, and so probably a smaller dose would have served the purpose. For the first two weeks fish died almost at once after being put in the water.

We had no idea what dose to apply in the stream, so the method employed was to use a certain quantity (½ to 3 lbs.) depending upon the rate of flow, etc., and then follow the effect. When the effectiveness (shown by dead fish) disappeared at any level downstream, we went back over a part of the area treated and added another amount of powder. It was found that if there was any current at all in the stream sprinkling the Derris on the surface was the most effective method of treatment. Where there were pools, squeezing it out of burlap sacks was perhaps the best method.

We were very anxious to destroy every fish above the hatchery dam, situated about a mile above the confluence with River Philip, and yet not kill any in the main stream. We believe we succeeded in doing this. Many fish were killed in the mile stretch above the junction but none in the main river. This result was secured by first draining the pond above the dam, and then when dead fish began to appear just below the dam the stop-logs were rapidly replaced and the pond allowed to fill up. A certain amount of poisoned water escaped, but the dilution on entering the main stream was great enough to render the water safe.


45° 31' N.
(1905) 20°35'W
63° 50' W.
CRANBERRY BOG LAKE
EASTERN BRANCH
CRANBERRY BOG STREAM
6
7
1
2
3
4
5
COLCHESTER CO.
CUMBERLAND CO.
McCORMICK LAKE
FALLS 25'
FALLS 6'
BRANCH
12
WESTERN
8
10
FALLS
FALLS 28'
FALLS 23'
9
SUGARLOAF MOUNTAIN.
1400 ft.
BROOK
45°38' N.
11
63° 50' W
SOUTHLOOP
TO WESTCHESTER
HATCHERY
JACKSON RD.
TO COLLINGWOOD.
RIVER PHILIP
TO WESTCHESTER
TO THOMPSON.
SECOND RIVER - COBEQUID HATCHERY.
0
0.5
1.5
2
MILES.

Each tributary was treated in the same way. Backwaters were searched out and treated, so that unless some of these other waters escaped the notice of our corps of workers we feel that complete eradication of the fish population above the new hatchery has been achieved.

The benefit we expect from this treatment is that the source of natural infection will have been removed, since it is well recognized that many diseases are borne by carriers. Fish live, eat, sleep, and die in the water. All the discharges from the skin, gills, and intestine pass into the water, so that one diseased fish could quite easily infect a whole hatchery of fish below, where they have to be held under quite crowded conditions. How successful we may have been only the future can reveal.

II

The poisoning of fish in Second River and McCormick Lake, as described above, gave an excellent opportunity to evaluate the fish population both qualitatively and quantitatively. In the past little attention, from the viewpoing of what these waters will actually support, has been paid by fish culturists to waters being stocked. Doubtless this lack of attention has been due largely to lack of opportunity for obtaining such information, but data could have been and can now be had in a great many of our freshwaters by an intelligent application of the poisoning method of eradicating fish life. True the application of fish poisons is restricted to the smaller bodies of water, owing primarily to the cost involved. However, fish poisons could be used expressly for sampling the fish life in various types of lakes and streams, or perhaps as a method for determining fish production in conjunction with the destruction of undesirable species or stunted populations. The use of fish poisons in fish cultural practices is largely of recent development (Catt, 1934; Smith, 1935; Eschmeyer, 1937) although Titcomb (1914) was probably the first person to destroy intentionally an undesirable fish population by this means. Present indications are that the procedure has promise for the future.

In Second River the fish in various sections of the main stream and tributaries were secured by placing nets above and below selected stretches of the stream. This prevented them from being washed from or into the section. In McCormick Lake, all the fish were collected as they came to the surface or drifted onto the shores.

Altogether, 12 sections were selected and the fish collected. Two of them (Nos. 6 and 12 on accompanying map) were well into the headwaters. Three (Nos. 7, 9, and 10) were on the main parts of two larger tributaries. The remaining 7 were located on the main part of Second River proper.

In the past Second River was used for driving logs and for this purpose a number of driving dams were erected, which now are largely washed out. In the old pond bottoms above these dam sites the stream is fairly sluggish and stillwaters are common. In general, however, most of the main stream below the junction of the East Branch and McCormick Lake outlet, and the West Branch, are flowing rapidly with intermittent pools.

In the old ponds and in most of the upper waters the bottom is, for the most part, muddy. On the main stream and West Branch boulders, rocks, and gravel predominate.

On the lower reaches the river is about 20 feet wide and an average of 4 inches deep (Sec. 11), while a width of 3 feet and a depth of 2 inches was found in Section 6 at the headwaters. Naturally the dimensions on the other sections fall between these two extremes. Moreover, these are summer levels.

Qualitatively, the fish population in the Second River System was poor. It was made up entirely of trout (Salvelinus fontinalis) and salmon parr (Salmo salar) except for 3 specimens of a cyprinid secured in the lower reaches. Falls on the main river and on the West Branch prevent the upward migration of salmon so that in a greater part of the system the only fish were trout.

In Table I are presented data showing the number of fish, the yield reckoned as per acre, and the average weight of the fish in the various sections.

Since the several sections represent almost as many separate ecological habitats it is not surprising to find that the production varies markedly. Section 2 is a stillwater with an average depth of 18 inches. Important from the viewpoint as a summer habitat for trout was the presence of a number of springs in the bottom providing an abundant supply of cool water. On August 12, 1937, the surface water temperature was 24.4° C., but on the bottom the temperature was decidedly lower at 8.1° C. As a result of these conditions trout congregated here in large numbers and a yield of 573.8 pounds per acre resulted. Section 1 was above and contiguous to section 2 and reflected a continuance of suitable conditions for trout, with a production of 234.1 pounds per acre. In contrast to these two sections was Section 3, situated some distance lower on the main stream. Here the water was spread in a thin sheet over a gravel bottom (average depth about 2 inches) and had a comparatively high temperature. Fish were scarce and those present were small, giving a yield of only 0.7 pound per acre.

Section 4 was a pool, average depth 20 inches, quite representative of those found intermittently along the course of the main stream, while Section 5 was the riffles and rock pools immediately below. The relationship between the production in these two types of habitats is well shown by the yields of 145.7 pounds per acre for the pool and 69.1 pounds per acre for the swifter water. The average weight of fish

was peculiarly larger for the riffles (Section 5) than for the pool and is explained by the presence of a greater number of fry at the head of the pool than elsewhere in the two sections.

The upper part of the stream because of the distance from roads was fished but seldom, while the lower course was, in comparison, extensively angled. Thus Sections 8 and 11, although waters similar to Sections 4 and 5, gave a much smaller yield of trout; namely, 19.6 pounds per acre in the former and 11.9 pounds per acre in the latter. In Section 11, the trout were also in competition with salmon parr (25.6 pounds per acre). The same was true in Section 9, located on the lower part of the West Branch, in which there was a total yield of 42.9 pounds per acre (20.8 trout and 22.1 salmon parr). In Section 10, higher on the West Branch, but not particularly dissimilar in character from Section 9, the trout yield was 47.2 pounds per acre, a production only a little greater than the total for Section 9. The two sections were thus apparently capable of providing the same crop, but the trout seemed to have suffered from competition with the salmon.

The two headwater sections, Nos. 6 and 12, yielded similar numbers of trout (5386 per acre for 6, and 5681 per acre for 12). The average weight per fish was somewhat larger in Section 12, so that the resulting crop per acre was greater, 84.8 pounds as compared with 65.2 pounds per acre for Section 6. In general, the fish were quite small in both sections.

The trout in McCormick Lake were, in average, the largest in the whole system, but in comparison the crop was small, namely only 8.4 pounds per acre. It is apparent, taking into consideration the muddy character of the lake bottom and shores, that all the fish found in McCormick Lake were immigrants from the stream below.

Since the work upon the collection of fish is still in progress, this article must be considered preliminary in character and subject to revision. Subsequent reports will provide information upon the lengths, weight, sex, age, migrations, food, and the ecological relationships of the fish population as a whole.

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TABLE I

SURVEY AND FISH DATA FOR SECOND RIVER AND MCCORMICK LAKE

Section.		1	2	3	4	5	6	7	8	9	10	11	12	McCormick Lake.
Length--in feet		243	213	289	66	207	272	243	1529	381	778	2067	171	
Av.Width--in feet		6.6	16.4	29.5	16.4	16.4	3.0	3.5	19.7	13.1	13.1	19.7	6.6	
Area--in sq. ft.		1593	3498	8525	1076	3391	817	850	30119	4986	10202	40718	1120	261360
No. of fish	(trout)	339	869	17	178	156	101	22	543	220	628	501	146	611
	(salmon)	..	..	..	..	..	..	..	..	79	..	455	..	..
No. of fish per acre	(trout)	9271	10820	87	7204	2004	5386	1128	785	1931	2681	536	5681	102
	(salmon)	..	..	..	..	..	..	..	..	690	..	4875	..	..
Pounds of fish per acre	(trout)	234.1	573.8	0.7	145.7	69.1	65.2	27.7	19.6	20.8	47.2	11.9	84.8	8.4
	(salmon)	..	..	..	..	..	..	..	..	22.1	..	25.6	..	..
Av. Wt. per fish--gms.	(trout)	11.5	24.1	3.4	9.2	15.6	5.5	7.2	11.3	4.9	8.0	10.1	6.8	37.5
	(salmon)	..	..	..	..	..	..	..	..	14.9	..	23.7	..	..

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CRAPPIE AND CALICO BASS CULTURE IN TEXAS

By D. C. Harper
Superintendent, State Fish Hatchery,
Cisco, Texas.

SOME TWELVE YEARS ago, when artificial propagation of fish in Texas was in its infancy, crappie were considered very difficult to propagate. Several methods were employed but for the most part they were miserable failures. It has since been proved that the ponds were grossly overstocked, the multiplied thousands of young fish starving before mid-summer. In recent years our general methods have changed, and with the successful introduction of rearing ponds, crappie and calico bass are now produced in numbers limited only by the available water area. Production figures as high as 31,950 two and one-half inch fish per acre of water and individual fish of eleven inches in length at seven months have been recorded.

The introduction of calico bass (black crappie) into the hatcheries has also stimulated production, as those fish are equally as prolific as their cousins the white crappie, and appear to be hardier, withstanding handling and shipping much better. Calico bass are very sparsely distributed over most sections of Texas, but they are now caught more frequently in many localities due to the excellent work of our nine fish hatcheries.

A very interesting piece of work has been carried on by the writer. Five years ago he secured a pair of large calico bass and retained the select off-spring, transferring them to several of the hatcheries, and last season many thousand of the fourth generation were distributed to the public waters of this State. So far, the fish have shown no ill effects of inbreeding, while on the other hand they have shown marked improvement by selective breeding. Good hatches have been secured from yearling fish which were six to eight inches in length. Last fall the yield from four pairs of calico bass of known age (four years, average length fourteen inches) was 24,025, or 6,006 fish per pair. Those figures exceed any record we have on crappie.

Rearing ponds have proved very successful at most of our hatcheries. The advanced fry are removed from the hatching ponds in late May and early June, usually by dipping them with a large net when they congregate around the water inlet. The Hesen trap has been used successfully in some cases. The rearing ponds, which have been well fertilized with barn yard or sheep manure, are stocked with from 10,000 to 20,000 advanced fry, depending upon the individual pond. In most cases a return of seventy-five to ninety percent can be expected, and the size of the fish will be in direct proportion to the available food supply.

In stocking ponds with a limited number of adults, where no advanced fry are to be removed, we have found that from three to five pairs of large breeders are sufficient. As our experiences have proved, it is far better to understock than to overstock.

During the summer of 1935, while Dr. A. H. Wiebe was associated with the Texas Game, Fish and Oyster Commission, some very interesting work was carried on at the hatchery located near Wichita Falls, concerning calico bass foods. Examinations were made of the stomach contents of fifty-one fish, taken from eight different ponds. The stomachs and alimentary tracts of most fish were well filled, some being gorged, while only two were completely empty. I am giving data showing the number of fish containing certain foods.

June 27-28-29 21 Fish, 1.6 to 3.0 inches long, from 8 ponds.

Midge Larva	12	Chydorus	2
Cyclops	10	Cladocera	1
Insect Remains	7	Bosmina	1
Ostracoda	5	Nematoda	1
Ceriodaphnia	5	Arcella	1
Mites	3	Midge Pupa	1
Diaptomus	2	Beetle	1
Damsel Fly Larva	2	Wasp	1
May Fly Eggs	3		

July 10-11 13 Fish, 1.9 to 3.0 inches long, from 7 ponds.

Midge Larva	9	May Fly Eggs	1
Cladocera	9	Damsel Fly Nymph	1
Copepoda	8	Adult Damsel Fly	1
Insect Remains	6	Adult May Fly	1
Mites	2	Dragon Fly Nymph	1
Cyclops	1	Empty	1
Small Snail	1		

July 22-23-24 17 Fish, 2.2 to 4.3 inches long, from 8 ponds.

Insect Remains	16	Damsel Fly Nymph	2
Cyclops	7	Notonecta	2
May Fly Nympth	7	Water Flea	2
Midge Larva	5	Ceriodaphnia	1
Ostracoda	5	Nematoda	1
Polyphemus	4	Beetle	1
May Fly Eggs	3	Copepoda	1
Midge Pupa	3	Ant	1
Wasp	3	Empty	1
May Fly Larva	2		

The foregoing is a fair indication of calico bass foods in the northern part of Texas. Unfortunately, similar work could not be carried out elsewhere. The fish used in the experiment were hatched the latter part of March. As the season progressed and the fish grew, there was to some extent a change in the diet. The rate of growth apparently indicates that there was an abundance of acceptable foods.

We do not feel that we have complete knowledge of the propagation of those fine pan fish but we are confident that we have improved on past methods and are continually experimenting, hoping to further expand our production. In our opinion, that can best be accomplished by increasing the food supply.

WHERE DO WE GO FROM HERE?

By Ralph W. Young
U. S. Fisheries Station
Salmon, Idaho

THERE IS CONSIDERABLE comment today to the effect that the golden age of opportunity passed with the frontier and the buffalo. This view may or may not be correct in many lines of work, but it surely is not true regarding fish culture. In fact we have hardly explored the possibilities. Fish culturists have been guilty of countless and often absurd blunders, however well intentional their efforts. Now with this not too bright past behind us we may face the future with the expectation of something more assuring to ourselves and the fishing public. To those hardy fellows who have been chiefly responsible for the progress to date, we have only the highest respect and admiration and we address the following, not to them but to those who are and have been "lying on their oars" and are content to be pulled up the stream of progress by the efforts of others. The writer, in the spirit of constructive criticism, offers a few suggestions whereby he believes the average hatchery may be improved from within. We shall stay within our field and limit ourselves to salmon and trout hatcheries.

Selective Breeding: Here is a subject that has been neglected shamefully by most hatcherymen, yet it ranks at the very top in raising everything from pigs to pineapple and from tomatoes to tom-cats. The writer feels no hesitation in venturing the guess that 90 percent of the state and federal hatcheries entirely neglect this highly important phase of fish culture.

Among all living things mutations occur. They are radical departures from the normal being -- experiments constantly being made by nature in an effort to improve the species. In most instances mutations are found to be undesirable and are discarded. However, sometimes mutations occur that are desirable and they not only survive but often replace the parent stock. Breeders of fish by careful observation may recognize them and take advantage of natural experiments. This already has been done in the development of albino trout.

The other method of developing a strain of superior animals or plants is to breed only those individuals which tend to resemble a preconceived product that is wanted. When the breeder has access to large numbers of individuals the desired end may be reached in a very short time. Fish fall into this category.

Breeders of mink desire a large, black, silky animal. By taking advantage of known natural laws they have been able to reach that end in a very few generations of mink. In fact ranch-raised mink pelts often sell for many times the price of wild caught mink. Yet fur-farming in general is a comparatively new industry.

We are all familiar with the development of the seedless orange, spineless cactus, seedless grape, ever-bearing strawberry, Burbank potato, and countless other variations from the original products. The methods by which these superior products have been obtained or evolved are contained in a science as exact as mathematics. Burbank knew that he could develop the spineless cactus as surely as he knew that two and two make four. We are equally positive that we can develop a fish that will be far superior to the wild variety. It only ramsins for the hatcheryman to do it.

Suppose you decided to quit raising fish and start raising, let us say, dogs. What would be your first step? You would round up 30 or 40 stray alley dogs, wouldn't you? Just any old dogs you happened to find. Why not? Haven't you been doing the identical thing in raising fish? If just fish are suitable for breeders, why aren't just dogs suitable for breeders?

Just what type of trout do we desire? The writer offers this suggestion: A rapid growing, disease resisting fish of high fertility and egg production. There are, of course, other considerations, namely, brilliant or unusual coloring, shape, size, gaminess, etc., which to the imaginative fish culturist must offer fascinating possibilities.

The time has come for fish culturists to begin producing pedigreed fish. The writer will admit readily that he is a hopeless crack-pot in suggesting the above, if someone will offer any logical reason why we should smile at the idea of pedigreed trout yet accept as perfectly reasonable pedigreed cats, dogs, mink, foxes, rabbits, and horses (and bet money on the latter).

The question will be raised as to the fitness of the offspring of these pedigreed fish to survive and successfully compete with the wild trout in their natural state. We can only say that we do not believe any such difficulty will arise. Most domestic

animals revert to the wild state with ease and are able to meet their wild brethern on equal terms and no favors asked. The domestic house cat is a classical example of reverting to the primitive. This animal, domesticated for many centuries, reverts to the wild state so readily as to cause us to wonder if it ever has been really tamed. Our guess is that trout will do likewise regardless of how far from the native stock we may breed them.

We state without fear of refutation that any step in the direction of selective breading of trout and salmon, however small, will certainly pay the highest dividends. What are we waiting for?

Improved Hatchery Equipment: No one can help being impressed, or even astonished, at the unchanged appearance of the interior of the average hatchery during the past 30 years. We like to imagine a modern Rip Van Winkle who, after sleeping 30 years, awakes to find a totally unfamiliar world and is able to live again in the past he knew only by getting a steady job at a fish hatchery. Shall we say that we can count the really new innovations or improvements on our 10 fingers and still have sufficient digits left free to play a saxaphone? Or is it because the writer, who is familiar with only 20 or so hatcheries, has had the misfortune to see the exceptional ones and not the average?

What about the standard hatching trough? Why should a wooden, grooved, square-end trough be called standard and accepted as such these many years? Are we fish culturists so easily standardized? Nobody accepted the Model T Ford as a standard automobile. Why do we have our troughs constructed with square ends and sides? Surely rounded corners would simplify cleaning and present a better general appearance. Why wooden troughs? Wooden troughs offer excellent media for the development of bacteria, recuire annual painting, soon become leaky, make a perfect-fitting tray impossible because of swelling and shrinking, and are heavy and awkward to handle. Why would not a metal, enameled, grooveless trough be far better suited to our hatcheries? Surely the wooden troughs we use could be improved upon. If so, why aren't they?

We need experimentation with various types of screens in the hatchery. A self-cleansing, foolproof screen would be of great benefit to any hatchery. Perhaps some are already available and in use. Certainly countless more complicated and ingenious devices are available for other uses. The point to consider is that the present type of screen has not, to the writer's knowledge, been changed or improved for 30 or more years. Does anyone consider that it cannot be improved? We can imagine the dinosaurs proudly surveying themselves and singing in unison, "We cannot be improved". But look what happened to them.

We might consider each piece of hatchery equipment and suggest ways and means of improvement, but in most instances the need is so obvious that we need not mention each specific instance.

Although most hatcheries have standard troughs, what fish culturist ever saw a "standard pond"? Ask 10 hatcherymen picked at random what kind of pond is best for raising any given species of trout or salmon and be not surprised at receiving 10 different answers. Ask 10 successful fox farmers what type of pen is best suited for raising fixes and be assured of being advised of one best known type. Why? Because scores of other types have been tried before arriving at the one used at the present time. We are still in the experimental stage and every hatchery has its various types and kinds of ponds, with conflicting opinions as to the respective merits of each. Perhaps the answer lies in the fact that each of the various species of trout and salmon requires a different type of pond under varying conditions as they exist in the hatcheries. For example, the Loch Leven trout will not do well in the ordinary cement raceway where rainbows usually thrive. This precludes the possibility of there being any such thing as a "standard trout pond". However, we may still expect the labels, "standard Rocky Mountain Loch Leven pond" and the "Pacific Coast Chinook rearing pond". The above of course open to improvement -- always. Remember the dinosaurs when that word standard is being used too freely.

As in our discussion on troughs we are again faced with the need for improvement on screens. Let no one answer that the screens usually used today are entirely satisfactory because they have stood the test of time and have always worked. The dinosaurs "worked" and stood the test of several million years of time. And if that illustration is too vague for some, let them recall how well the Model T worked for nearly as many years as our screens.

We will cease our discussion on ponds by suggesting that as in the case of troughs we need ponds so constructed that prophylactic measures will be really effective instead of hopeful.

Scientist Versus Hatcherman: Upon this subject we shall speak briefly, but perhaps not briefly enough. The best way to jump into cold water is to jump in -- so here goes. The average hatcheryman (to the best of the writer's belief and subject to correction) regards the scientist or "bug hunter" with something not far from contempt well seasoned with amusement. The writer falls over himself in his haste to add that he does not necessarily hold to that opinion himself, and in the vulgar language of the street tucks in his chin.

We offer some possible reasons for the average hatcheryman's lack of enthusiasm toward the fishery scientist: (1) He feels that the scientist fails to have a full appreciation of the hatchery's practical problems. (2) That the scientist disregards the experience of the hatcheryman, in favor of his own experience in raising fish under conditions that are not typical of the average hatchery. (3) That the scientist should furnish instruction in the use of the microscope at the hatcheries, so that the fish culturist may identify fish diseases himself. (4) If the foregoing is impractical, that the scientists should prepare slides of the more common diseases, to be used by the hatcheryman in learning to identify diseases. (5) At least a few of us feel that the fish doctor is whistling in the dark when he "identifies" diseases from fish preserved in formalin. He might identify a few protozoa but he cer-

tainly cannot identify any of the bacteria. If this statement is inaccurate, we shall be pleased to have some scientist correct us and name some specific bacteria that can be identified from fish preserved in a 10 percent solution of formalin. Our chin is way out on that one.

In the PROGRESSIVE FISH CULTURIST, No. 3, page 5, Dr. Fish, in his article, "The Microscope in the Hatchery", writes, "Place this prepared slide on the stage of the microscope and under the low power objective, search the entire area under the cover slip for moving organisms. In such a preparation, one may expect to find Cyclochaeta, Chilodon, Ichthyophthirius, or Gyrodactylus". He then states that if a microscope is not available at the hatchery, the diseased fish should be preserved in formalin and forwarded to one of the Bureau of Fisheries laboratories where "information concerning the disease present and the proper methods of treatment will be returned immediately". He then qualifies his statement by adding, "This method of diagnosing fish diseases by mail does have certain limitations.....However, the majority of the more common diseases of fish can be identified in this way". We consider the last statement to be inaccurate.

Now that we have thrown so many brick bats, we shall hurl at least one bouquet in the direction of the excellent publication, THE PROGRESSIVE FISH CULTURIST. Long may it live and prosper! We feel sure that it will not go the way of the dodo and dinosaur -- or at least not very soon.

COMMENTS FROM OUR READERS

LOSS OF MEXICAN TROUT

Editor, the Progressive Fish Culturist:

Quoted below is a letter dated March 21, 1938 from Mr. A. C. Taft, California Division of Fish and Game, with regard to our Mexican trout at the Forest Home Hatchery:

> "On March 2 and 3 heavy rains, followed by a series of cloudbursts, caused a flood in Mill Creek Canyon which caused the total loss of the Forest Home Hatchery. All that remains in usable condition is the superintendent's house, bachelor quarters, and the upstairs of the hatchery. The lower floor of the hatchery where the eggs taken from the Salmo nelsoni were being held was filled with boulders and gravel and all of the fish either killed or lost. The tank at the upper end of the grounds which contained the adult fish was also buried under tons of rock and gravel and it seems apparent that all the fish have been lost, although at the present time the tank has not yet been uncovered.

"I, of course, regret that these fish have been lost since our interest in your planned experiments with them was very great."

The possible catastrophe mentioned in my article sent you for publication in the PROGRESSIVE FISH CULTURIST has now occurred. The floods in Southern California wiped out the Forest Home Hatchery and our S. nelsoni with it. The irony of this is the fact that we had just spawned the first batch of eggs on February 17 last, and we not only lost the adult stock but the eggs as well.

In discussing the matter recently with the U. S. Forest Service officials in San Francisco, the suggestion was made that we go back again in the middle of June this year to secure another lot of these fish. They are willing to finance half of the expense and I, personally, believe we should do this and not remain licked on this proposition. We know all the angles involved now, and could easily secure another lot of these fish alive. We still have the insulated ice cases and other equipment used last year and the only expense would be for travel and gas and oil for one truck. The Forest Service will furnish a second truck. After obtaining the fish again, they might well be placed in one of the western hatcheries not subject to extreme floods.

Paul R. Needham
Associate Aquatic Biologist
U. S. Bureau of Fisheries
Stanford University, Calif.

(NOTE: The Bureau of Fisheries has authorized a second attempt to secure and acclimatize Mexican trout in California.)

AN EXPERIMENT ON HEATING WATER FOR FISH CULTURAL PURPOSES

Editor, The Progressive Fish Culturist:

Some years ago the spring that supplied water for the U. S. Fisheries Station at Spearfish, South Dakota, failed, and since then it has been necessary to utilize water from Spearfish Creek, the temperature of which drops to as low as 33°F. during the period from November to and including March. It is during this period that the brook and Loch Leven trout eggs are handled at the station. The results of this incubation are unsatisfactory because the eggs are slow to hatch and the fry, usually premature, are consequently raised with considerable difficulty.

This is a familiar problem at stations using water of low temperature. Temperature studies at the School of Fisheries, University of Washington, Seattle, have confirmed the undesirable results of low temperature incubation.

Heating water in a fisheries station has always been a thing to approach with timidity. Since the Spearfish station is an important link in the Bureau of Fisheries' system of trout hatcheries, and through sheer necessity, it was decided to experiment with heating the water entering the hatching troughs. The results of this experiment, conducted during the past winter, have been so gratifying that, by direction of Mr. Glen C. Leach, Chief of the Division of Fish Culture, and Mr. Fred J. Foster, Regional Director, the experiment is here described.

This report is necessarily general in nature, since the experiment was conducted merely as a "feeler" to try to improve the natural temperature condition, and a thorough tabulated report was not kept. The results have been, as before mentioned, so astoundingly gratifying that it is believed others encountering similar conditions will be interested.

The experiment was set up in one series of two troughs, using a natural gas-fired, double-coil heater, similar to those used in heating water for domestic purposes. The heater was shunted across a by-pass valve on the one-inch trough supply pipe, so that by the use of the valve the amount of water flowing through the coils of the heater could be regulated. The remainder of the water flows past the valve, unites with the heated water, and flows into the trough. By adjusting the valve and the flame of the heater, a double control on the water temperature is effected. As a further safety measure to prevent overheating, a motorized valve controlled by a thermostat is installed in the gas service line supplying the heaters. When the water reaches a temperature of 55° F. (or any other predetermined temperature) the gas immediately shuts off and an alarm bell rings until shut off manually.

The experiment covered the period from December 22, 1937 to February 18, 1938. All troughs were of the standard 14-foot size and a similar arrangement of two of these troughs were used as a control. In each of these troughs were placed 9,500 green brook trout eggs taken on the same day shortly before the experiment was started.

The temperature of the unheated water averaged 35°F. during the experiment. The heated water was first adjusted to 50° F. and 10 days later reduced to 46° F. The water flow was adjusted to five gallons per minute into each trough.

A separate gas meter was installed to measure the gas consumed, which averaged 700 cubic feet per 24 hours, costing $0.21.

It is planned, when permanent installation is made, to so arrange the vent pipes of the burners that little additional heat will be necessary to heat the hatching room even in severe weather. It is obvious also that by careful arranging of the troughs a further saving can be made in gas consumption. Then, too, the writer feels it will not be long until the Western Drip Incubator is universally adopted in processing eggs. This device will operate with 80 to 90 percent less water and the fungus growth on the eggs is practically eliminated. This incubator is being tried

out and developed at several of the western stations under the direction of Mr. Foster and will be described by him after complete data are collected.

The results of using this heated water must necessarily be generalized. It is regretted that complete data were not formally tabulated, but the results as here set forth are accurate even though of a general nature.

Trout fry hatched in the ordinary water supply unheated, left, and in the heated water as described in the accompanying article, right. Both lots of fish are of the same age.

Briefly, the fry incubated with the heated water were infinitely superior to those in the control. They hatched normally and were vigorous and healthy. The fry in the control or unheated water were decidedly inferior, being premature and weak and hatched many weeks later than those of the heated water. The long incubation period caused the shells to become thin and the eggs to hatch before the proper number of temperature units were absorbed. It is then with great difficulty that the fry are raised to fingerlings. This condition is comparable to any premature birth and the hazards of survival are the same.

It was noticed that there was less trouble from fungus growths on the eggs in the heated water. This probably is attributed to the fact that the water passed through the copper coils, since it is a well known fact among bacteriologists that metallic copper has a sterilizing effect on water. It is, therefore, reasonable to believe that the water passing through the copper coils should have some beneficial effect in preventing bacterial gill and fin infections among fingerlings.

T. S. Kibbe, Foreman
U. S. Fisheries Station
Spearfish, South Dakota

A SELF-CLEANING, REVOLVING SCREEN FOR USE IN BROOD STOCK AND REARING PONDS

Editor, The Progressive Fish Culturist:

A self-cleaning screen in simple terms is a paddle wheel mounted in a frame. It is made to slip into the slots of a pond outlet like a splash board or a screen. The wheel is covered with wire screen to keep fish from escaping into the overflow. The wheel is driven by the flow of water exerting pressure against the paddles.

Self-cleaning, revolving screens have been used extensively at our Paris State Fish Hatchery since 1931. As early as 1922, one revolving screen was in use, and although addicted to stopping at frequent intervals, due to a long bearing surface which consisted of one three-foot water pipe revolving inside another larger water pipe, we considered the wheel a part of our institution and kept it in repair through the years.

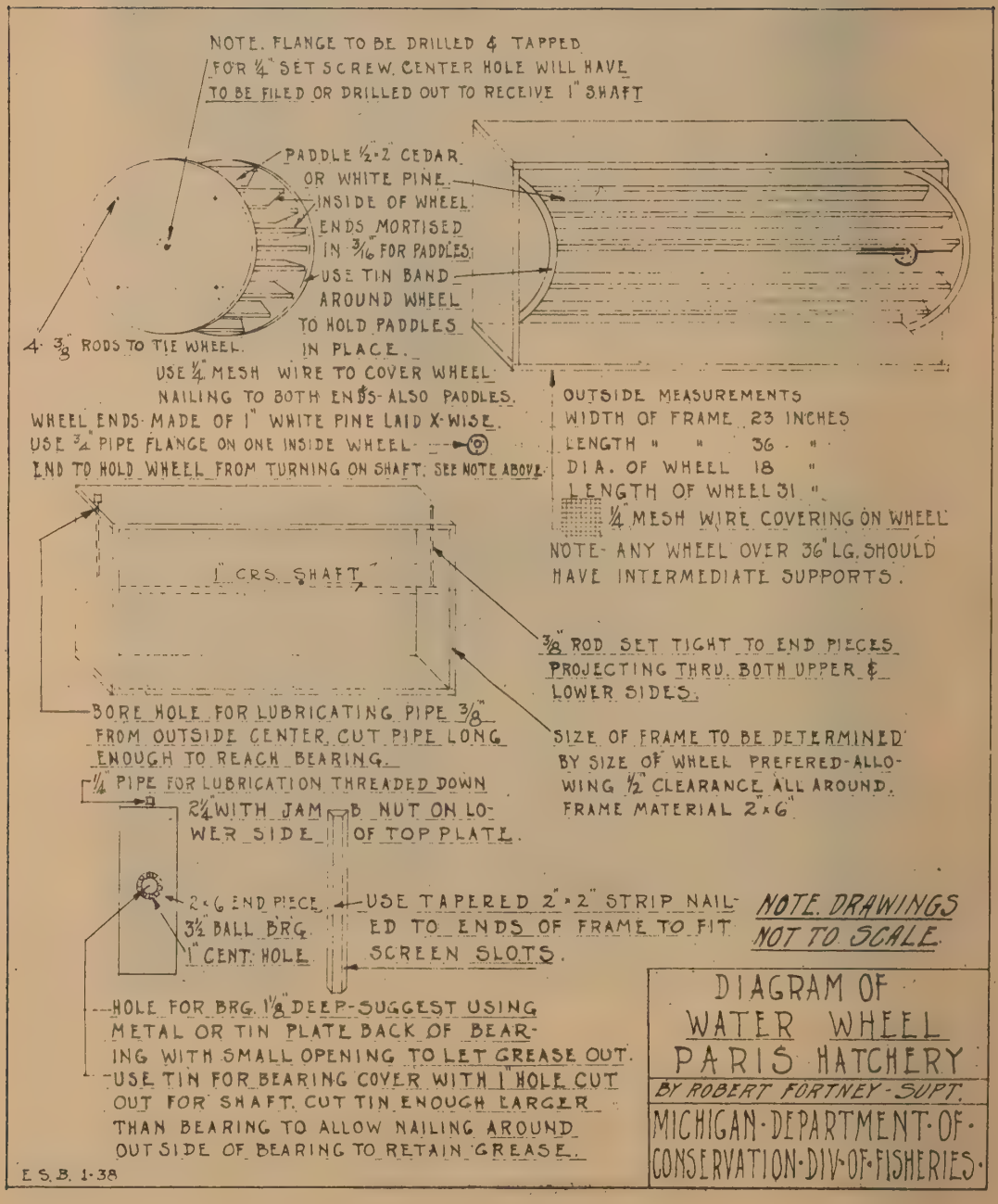
We have been and always will be troubled with an algal growth in the bottom of our adult brown trout ponds. Our brood stock pond system is quite extensive for an annual take of several million eggs is needed to meet Michigan's requirements, and in such a pond system a great many screens demand cleaning and attention. On bright sunny days in summer the troublesome algal growth in the bottom of the ponds rises to the surface, clogs, and stops the circulation of water in the old type bar or woven wire screen. During such times pond screens require a great deal of additional care.

An expansion program which added three new trout rearing stations to the Paris district increased the duties of our Senior Fish Culturist in charge of feeding. He was expected to keep all screens clean in the pond system at Paris, prepare the trout diets, and do all the trout feeding. We then asked him to prepare the additional trout diets for the new rearing stations. He told us that he could take on the additional work if so much of his time was not required to keep pond screens clean. Here was a problem -- too much work for one man and not enough for two. We

A self-cleaning, revolving screen for fish ponds used in Michigan.

Above: View of screen assembly removed from slots in the overflow.

Below: View of screen in position.


NOTE. FLANGE TO BE DRILLED & TAPPED FOR ¼" SET SCREW. CENTER HOLE WILL HAVE TO BE FILED OR DRILLED OUT TO RECEIVE 1" SHAFT
PADDLE ½ x 2 CEDAR OR WHITE PINE. INSIDE OF WHEEL ENDS MORTISED IN 3/16" FOR PADDLES
USE TIN BAND AROUND WHEEL TO HOLD PADDLES IN PLACE.
4 - 3/8" RODS TO TIE WHEEL.
USE ¼" MESH WIRE TO COVER WHEEL NAILING TO BOTH ENDS - ALSO PADDLES.
WHEEL ENDS MADE OF 1" WHITE PINE LAID X-WISE.
USE ¾" PIPE FLANGE ON ONE INSIDE WHEEL END TO HOLD WHEEL FROM TURNING ON SHAFT. SEE NOTE ABOVE.
OUTSIDE MEASUREMENTS
WIDTH OF FRAME 23 INCHES
LENGTH " " 36 " "
DIA. OF WHEEL 18 "
LENGTH OF WHEEL 31 "
¼" MESH WIRE COVERING ON WHEEL
NOTE - ANY WHEEL OVER 36" LG. SHOULD HAVE INTERMEDIATE SUPPORTS.
1" CRS. SHAFT
3/8" ROD SET TIGHT TO END PIECES PROJECTING THRU. BOTH UPPER & LOWER SIDES.
BORE HOLE FOR LUBRICATING PIPE 3/8" FROM OUTSIDE CENTER. CUT PIPE LONG ENOUGH TO REACH BEARING.
¼" PIPE FOR LUBRICATION THREADED DOWN 2¼" WITH JAM NUT ON LOWER SIDE OF TOP PLATE.
SIZE OF FRAME TO BE DETERMINED BY SIZE OF WHEEL PREFERED - ALLOWING ½" CLEARANCE ALL AROUND. FRAME MATERIAL 2" x 6"
2 x 6 END PIECE
3½" BALL BRG.
1" CENT. HOLE
USE TAPERED 2" x 2" STRIP NAILED TO ENDS OF FRAME TO FIT SCREEN SLOTS.
NOTE. DRAWINGS NOT TO SCALE.
HOLE FOR BRG. 1⅛" DEEP - SUGGEST USING METAL OR TIN PLATE BACK OF BEARING WITH SMALL OPENING TO LET GREASE OUT.
USE TIN FOR BEARING COVER WITH 1" HOLE CUT OUT FOR SHAFT. CUT TIN ENOUGH LARGER THAN BEARING TO ALLOW NAILING AROUND OUTSIDE OF BEARING TO RETAIN GREASE.
E.S.B. 1-38
DIAGRAM OF WATER WHEEL PARIS HATCHERY
BY ROBERT FORTNEY - SUPT.
MICHIGAN - DEPARTMENT OF CONSERVATION - DIV. OF FISHERIES.

looked around for a solution. Our eyes fell upon the old water wheel. Why not build a better one? One more regular in its habits, and in addition build self-cleaning screens to take the place of the troublesome old type in the pond system. We started to build what we hoped would be an improved, self-cleaning, revolving screen.

The first step was to improve the bearings, and we finally decided on 3½ inch roller bearings with 1-inch center hole to take care of a cold roll 1-inch solid shaft. Subsequent trials and tests over a period of seven years have proved the wisdom of this decision. We did make one mistake, however, in building our first improved revolving screen. Lubrication was not provided. Bearings started to show wear and after the first year grease pipes with hard oil cups were provided to eliminate wear on the bearings. Most of our ball bearings were bought from used parts establishments and cost from 50 cents to $2.00 per bearing. They were as good as new and only needed a thorough cleaning before being put to work. As the initial expense of building a self-cleaning, revolving screen is quite high because of labor costs, we used only the best materials to insure long life. When our improved revolving screen was finished and put to work we viewed it with considerable pride. The screen ran like a watch and looked so practical that we immediately started to build more. R. M. Brodrick, a mechanical-minded Senior Fish Culturist of the Paris organization, built the improved self-cleaning, revolving screen and recorded labor and material costs which are listed below.

Although the diameter and width of a revolving screen should be governed by the measured stream flow, we have screens of different diameters and widths in use at Paris, yet the measured stream flow or gallons of water per minute flowing through the wheels is the same. For instance, three revolving screens are in use which are six feet long over all. In this case double wheels are used with a center support in the frame carrying one ball bearing. The shaft, however, is in one piece. The diameter of the wheel must also be governed by the desired height of water level that is to be carried in the various ponds. Our ponds at Paris have a fall over their length which enables an 18 inch wheel to maintain the water level desired. All of our self-cleaning screens rest on splash boards which are brought to the proper height. The space between the revolving wheel and the top of the frame is ½ inch. Also, the space between the ends of the wheel and sides of the frame is ½ inch. This provision screens all trout successfully from eight inches upward in size. From a mechanical standpoint it is entirely feasible to build the revolving screen with such precision that one would need to allow only ¼ inch spacing between the wheel and frame, thus enabling smaller trout to be screened effectively.

Obviously, judgment should be used in building self-cleaning screens in relation to the gallons per minute of water available. With a small flow such as 100 gallons of water per minute, it is reasonable to assume that a revolving screen 12 inches in diameter and 18 inches long would work perfectly. Were it not for the hazards of floods a stream 100 feet wide could be screened by self-cleaning, revolving screens, provided certain engineering plans and proper diameters were observed.

Apart from the practicability of the self-cleaning screens, they serve as a rather picturesque and attractive feature in the landscape of a trout hatchery. Visiting tourists observe them with curiosity and respect. Not with so much respect, however, as the man who cleans screens which are not revolving and self-cleaning.

Bill of Material and Cost of Self-Cleaning Screen as Shown in Illustration.

Two 3½" used ball bearings with 1" center hole	$ 2.00
Two ¼" hard oil grease cups	.50
One 34" cold roll 1" steel shaft	1.10
Two feet of 1/8" pipe to grease bearings	.25
Two floor flanges with ¾ center hole drilled out to 1 inch	.50
Two ¼" to 1/8" pipe reducers for grease cups	.20
Two ¼" set screws for flanges	.10
Ten lineal feet of 1¾" tin bands to cover edges of wheel	.60
Five lineal feet of ¼ mesh wire 31" wide	1.50
38 lineal feet of 2" x ½" cedar or white pine for paddles	.65
Twelve lineal feet of 7/8" x 10" white pine for wheel ends	1.20
Ten lineal feet of 2" x 6" for wheel frame. Fir or white pine	.85
Four lineal feet of 2" x 2" tapered for wall slots to hold wheel in place	.20
A sheet of heavy tin for bearings 8" x 10"	.25
Four 3/8" rods 32" long to hold wheel together	.60
Four 3/8" rods 24" long to hold frame together	.50
One quart of aluminum paint	1.00
24 hours at 70 cents per hour, skilled labor	16.80
	$28.80

Robert Fortney
District Superintendent of Fishery Operations, Michigan Department of Conservation.

A SIMPLE TROUGH CLEANER

Editor, The Progressive Fish Culturist:

I have received your PROGRESSIVE FISH CULTURIST for sometime and find it a source of valuable information. I have been in the fish business for several years, but like most fish culturists have a lot yet to learn. I have devised a simple "doo-dad" that comes in very handy this time of year and for a few months to come;

namely, a simple trough cleaner. It consists of a length of rubber hose that can be attached to any water outlet in the hatchery, equipped with a special nozzle of copper pipe bent and flattened to produce a spray of water for washing down the troughs. I use about 16 feet of 3/8" rubber tubing to the end of which is attached the nozzle made from a length of copper tubing such as is used on automobile fuel systems, 12" long by 3/8". The nozzle is bent into an elongated "S" shape and the end is flattened with a few light taps from a hammer, leaving an opening about 7/16" by 1/16". The tip is filed smooth. The hose may be connected to any water tap in the hatchery,but if none are convenient a simple connection can be made with the supply pipe in the hatchery troughs by making a cone-shaped wooden block about 4" long bored through the center to receive a 3/8" male elbow. The hose can be slipped onto the end of the elbow and the wooden block screwed into the water supply solidly enough to hold for each period of use.

Now to use this contraption let the water down slowly in the trough by removing the discharge pipe and tapping the outlet screen to clean it of liver, etc. A small block of wood is placed over the discharge pipe to drain the water down slowly and yet have a good flow through the trough. The hose of the trough cleaner is connected to the inlet pipe from another trough, not the one being cleaned, and the spray of water from the nozzle is worked back and forth the width of the trough, holding the nozzle on the bottom and working it toward the discharge to clean away the dirt.

After using this original design, I introduced a refinement which permits the regulation of force of water through the nozzle. This is a valve which is simply a wooden spigot such as is used on wooden barrels, the copper nozzle being worked into the end of the spigot that enters the barrel and the supply hose being attached to the delivery spout of the spigot. Control of the flow at the nozzle is especially desirable when the supply hose is attached to a hydrant in the hatchery where more pressure is secured than from the pressure of gravity in the trough supply.

I use my trough cleaner in washing fry down the discharge pipe and catching them in a large tub when I salt the trough and give the fry a dip. I also use it with the valve almost shut to supply fresh water to the tub of fry while they are being held, thus supplying them with aerated water.

I introduced my gadget to the superintendent of the state hatchery here in Valentine a few days ago and he grinned from ear to ear. After cleaning a trough himself he removed his hat to me. This was not what I wanted, however -- I only want to add my little help to this trout business, yet in its infancy. I would never go back to the old fashioned methods of cleaning troughs by using feathers or a syringe. They are all right for ducks and babies, in their respective order of course, but for cleaning troughs give me some hose every time. After using the hose for two years I have found that absolutely no harm has resulted.

Now, Mr. Editor, if you can boil this down to 50 words you are doing much better than I. After all, what is an editor for?

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REVIEWS

THE SMALL-MOUTH BASS

By Dr. Carl L. Hubbs and Reeve M. Bailey, Cranbrook Institute of Science, Bloomfield Hills, Mich., Bulletin No. 10, January 1938. R. R. Donnelley & Sons Company, Chicago, 89 pp. frontis, 9 pls., 3 figures. Dec. 1937.

In the brief introduction to Hubbs and Bailey's pamphlet on bass mention is made of the growing popularity of the small-mouth bass as a game fish. The high regard with which anglers hold this fish, it is stated, is attested by the countless articles, stories, and several books about it which have appeared.

This is followed by a detailed account of the classification and identification of the black basses. This is written in a clear-cut style which makes it useful both to the layman or "beginner" and to the scientist. A key for the identification of the black basses in technical terms is given. The use of technical terms is prefaced by a glossary and figures explaining them. One may identify three species of black bass from this key; namely, the small-mouth Micropterus dolomieu, originally found from Quebec to northern Minnesota and south to eastern Oklahoma and the Tennessee River drainage; the spotted bass, Micropterus pseudoplites - distribution, southern Ohio and West Virginia to southern Illinois, southeastern Kansas, eastern and southern Oklahoma, and east-central Texas; east to Alabama, western Georgia and the Tennessee River drainage of Virginia. Huro salmoides, the large-mouth bass, the third species was originally found from southern Canada throughout the entire Great Lakes system and the Mississippi Valley to northeastern Mexico and Florida, and north along the coastal plain to North Carolina. The points of difference between the spotted bass and small-mouth are dwelt upon at some length, and the habitats of all three species are compared.

In the north, the spotted bass divides territory with the small-mouth, which lives nearer the headwaters of the same streams in the clearer and cooler waters where the bottom is more frequently composed of gravel, while the spotted bass prefers rather sluggish streams with muddy bottoms. But in the south, the spotted bass is found in the cooler and clearer headwater streams where pools and riffles of coarse gravel and sand alternate.

The authors state that in the Gulf States there are no true small-mouth bass, but large-mouth and spotted bass are common. A footnote announces that there are additional kinds of bass in the southern states.

On page 20 of tis publication is given an excellent and, from the reviewer's own angling experience, accurate statement of the angling qualities of the two species. They say "the first rushing strike of the large-mouth is fully as furious as that of the small-mouth, but the fight is usually briefer and less fierce, and the characteristic rushing leaps of the small-mouth are seldom made by the large mouth. Many of the older accounts of the fighting ability of the large-mouth are probably colored by the confusion of this species with the recently recognized spotted bass of the Mississippi Valley. However, no small number of sportsmen are ardent admirers of the large-mouth, feel that it is the equal of the small-mouth as a fighter, and claim that where it lives in cool and clear waters it acquires the fighting and even leaping habits of the small-mouth."

Under a section entitled, "Characters of the Small-Mouth Bass", are discussed points of identification such as body dimensions, scale ratios, color, position and relationship of fins and bones, air-bladder, etc. These points are compared with the same characters in large-mouth bass and other fishes. It is stated that it is rather generally believed that the characters discussed in the section indicate a progressive evolutionary change from the more primitive group of bony fishes, the Malacopterygians to the Acanthopterygians, which are typified by the small-mouth bass.

In regard to the distribution of the small-mouth, it is stated that this species in all probability never lived originally in the Atlantic coastal rivers. The approximate original distribution included the Great Lakes and St. Lawrence system, and the upper Mississippi, Ohio and Tennessee River systems. The manner in which the range of this species was probably extended is described. Cool, flowing streams strewn with gravel and boulders, and large clear lakes are the favorite haunts of the small-mouth. It shows a marked tendency to be most abundant in lakes in the northern portion of its range and in flowing streams in the southern part. This phenomenon is explained chiefly as a temperature effect. Good small-mouth lakes are defined as lakes of area in excess of 100 acres, depth should exceed 30 feet, with thermal stratification; clear, light-colored waters of moderate summer temperatures and lakes with scanty vegetation are preferred. The presence of suitable gravel or rocky areas is essential for satisfactory spawning. In streams the small-mouth prefers a good gravel or rocky bottom, clear, cool water, and a good current. Slow roily, lowland streams and lakes with mud bottoms and abundant vegetation are unsuited for small-mouth.

Of particular interest to the reviewer was reference to the occurrence in groups of five or ten of small-mouth in the wave-churned offshore shoals of the eastern shore of Georgian Bay. A similar distribution of adults in groups of this size has been noted by the reviewer in the Shenandoah and Potomac Rivers and their tributaries.

Small mouth do not enter the unconscious, sleep-like condition of certain mammals and reptiles, according to these writers, nor do they generally hibernate in sunken hollow logs and crevices, although they have been found in these situations. They do become inactive in late fall and winter, take practically no food and seek seclusion in the deeper waters.

Net building activities and spawning occur at water temperature of from 59° to 65° F., and it is stated that the small-mouth spawns earlier than any of the centrarchids with which it lives. It is suggested that sunlight is a factor of importance in determining the nesting depth and the activity of breeding fish. A change in the color pattern of the female during spawning is described in detail as well as nest building, spawning, development of the eggs and young fish. In the section upon age and growth one finds a brief explanation of the method of determining the age of bass as well as data upon the growth rate and the maximum age and size attained by small-mouth bass. The record fish is one taken at Oakland, Florida, in February, 1936, weighing fourteen pounds. Throughout its range, the small-mouth is a smaller fish than the large-mouth.

Small-mouth feed by the "grabbing and gulping" method, not masticating their food at all. In general, the food items which predominate in the successive growth states of the small-mouth bass are as follows:

(1) Copepods and cladocerans
(2) Insects
(3) Fish
(4) Crayfish
(5) Finally fish again.

These writers state that the bass tapeworm, Proteocephalus ambloplitis is perhaps the most serious enemy of the small-mouth bass because it affects the reproductive organs so that few or no young fish are produced. It is pointed out that infestation with bass tapeworm probably is commonly spread during the spawning of the bass. If the adult nest-guarding male bass is infested, an abundance of tapeworm eggs is produced and a large proportion of the copepods, which eat the eggs in the vicinity of the nest, become first intermediate hosts. The developmental period of tapeworm eggs in copepods is about the same as that of developing bass eggs and fry which feed upon these copepods upon rising from the nest. These young bass become infested as second intermediate hosts. Other second intermediate hosts are fish common in the food of the species. Two other species of Proteocephalus occur in small-mouth, one of which is harmless. Even obviously "grubby" fish are safe and wholesome to man employing the ordinary methods of cooking used in America.

Taste buds are found in fish on the tongue, lining of the mouth and throat and on various other parts of the body. The olfactory organs of the small-mouth bass are a pair of small sacs, one on each side of the snout about midway between the tip of the upper jaw and the eye. It is believed that the function of smell is of prime importance in their lives. The lateral line organs serve as a "sixth sense" to fish and enable them to detect mass movements of the water, whether due to slow vibrations or to current. It is believed that through them fish detect approaching enemies, and food that falls in the water and avoid swimming against obstructions in the dark. Vibrations short enough to be audible to man, are not received by the lateral line organs.

Other senses, the sense of hearing, touch and sight are also discussed. The points of difference between the vision of man and fish are elaborated upon. At least large-mouth bass are able to recognize and discriminate between colors. A section on angling is very brief, and the reader is referred to the publications of Henshall, Loudon, Harris and Bean, and the recent books of Kennedy and Gallaher.

Under the heading "Artificial Propagation" are discussed two general methods, namely, the extensive method which makes use of large ponds from two to fifty acres, where the young fish feed on natural food, and the intensive method involving constant feeding in rather small ponds, usually less than an acre in extent. Their classification omits the size of ponds upon which a large amount of experimental work has been done in recent years - e. g., ponds one-half to two acres in area which are usually stocked with forage minnows and fertilized at regular intervals to obtain the maximum production of natural food organisms. The intensive method as originally employed in Ohio is described briefly. The reviewer believes it a mistake to suggest small ponds (one-fourth acre) as desirable for holding adult bass over the winter, rather, the reverse -- the larger the brood stock wintering ponds, the better. In small ponds, parasites such as Ichthyophthirius, Gyrodactylidae, and Cyclochaetes multiply once they get started.

The publication is concluded with comments on the causes of depletion of bass waters and remedial measures.

This bulletin is very well and interestingly written. It apparently contains few original observations, or new scientific data on the small mouth, but it does a fine job in bringing together our knowledge of the species.

Eugene W. Surber.

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